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ADDRESSES

DELIVERED AT THE DEDICATION OF THE

DAIRY INDUSTRY

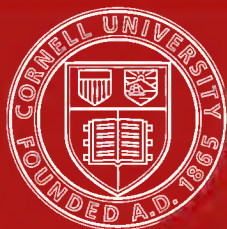
AND THE

HORTICULTURE BUILDINGS

UNIVERSITY FARM, DAVIS

OCTOBER 24, 1922

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DAIRY RESEARCH AND EDUCATION

RAYMOND A. PEARSON

President of Iowa State College of Agriculture and Mechanic Arts

IMPORTANCE OF DAIRYING

The importance of research and education in dairying are best realized when we consider the extent of the dairy industry and its complexities.

The Chief of the Dairy Division of the United States Department of Agriculture states that one hundred billion pounds of milk were produced in the United States in 1921. At six cents a quart the farm value of this milk was about two and one-half billions of dollars. It would require the gold produced by all the mines in the United States during the last forty-five years to equal this value.

The same authority tells us that the milk produced in 1920 was used in the following manner:

Household purposes.....	43.7	per cent
Butter making.....	36.	per cent
Cheese making.....	4.	per cent
Condensed milk.....	4.4	per cent
Ice cream.....	4.	per cent
Other products.....	.2	per cent
Calf feeding.....	4.7	per cent
Waste or loss.....	3.	per cent

Total.....	100.0	per cent
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It would take three of our national wheat crops like that of 1921 to purchase the dairy products of that year. All the beef cattle in the United States, and twice all the hogs

and sheep, if sold at the farm values of January 1, 1922, would yield only enough to buy all the dairy products produced in 1921. The ultimate consumers in the United States pay between three and four billion dollars per year for these dairy products.

The successful conduct of dairy production, manufacturing and sales, and the proper education of the public as to food values of dairy products require the application of science at almost every point. Rule of thumb methods long since were discarded.

Twenty-five years ago the task of preparing a report on dairy education in the United States was assigned to your speaker. The report was published by the Federal Department of Agriculture and contains this statement: "Modern advances in dairy knowledge have been rapid; the scientist and inventor have caused the apparatus and routine in use a quarter of a century ago to be almost entirely discarded and replaced by more profitable machinery and more accurate methods. . . . It is probable that these improvements have not much more than begun." These words written twenty-five years ago now may be repeated in relation to the quarter of a century since the report was written, for they apply to that twenty-five years as well as to the preceding twenty-five years. During the combined period of fifty years most of the improvements in dairying have been brought out.

EARLY HISTORY

Perhaps sometime someone will paint a series of pictures representing the progress of the dairy industry and showing how this progress has depended upon the application of knowledge developed through scientific research. The first picture would date before civilization and would not show much in the way of food, clothing or shelter for human

beings but it would show enough to impress the fact that dairying is the oldest of our great industries. History tells us that the Scythians and the Greeks used butter 2500 years ago. Ancient pictures show how the Arabs made butter by churning milk in bags of skin which were agitated by swinging back and forth when suspended from the limb of a tree.

Finally it was discovered that cream would rise to the surface and that this was the important part of milk for buttermaking. Then during a period of hundreds of years, cream was raised by the gravity method. As a little boy I can remember helping to "skim the milk" from large shallow pans which were kept on shelves against the cellar wall. I wonder if anyone ever has computed the amount of butter fat that was lost during the years of shallow pan creaming.

We now say that the problem of creaming milk in the days of our grandfathers was simple. But at that time it was difficult. Most people, if they thought about it at all, probably thought the shallow pan system was near enough to perfection. A few were trying to think of more efficient methods but their range of thinking did not go beyond the natural gravity process. Gradually deep setting methods were developed and proved to be an advance over the old style. These methods depended upon the same general principles as the older method and were an improvement because of certain minor changes.

There was another way of solving their creaming problem, but no one thought of it for years and years. A statistician might be able to tell how much butter fat was lost during the deep setting period. Its value would run high in the millions of dollars.

At last there came a genius, one man with knowledge of fundamentals, and with a vision which was destined to

revolutionize the industry. The vision of that man grew in the minds of other men into definite ideas which finally were translated into instruments of steel and precision, and so the centrifugal separators came into use about forty-five years ago.

Many problems in dairying are with us today—some of them not even recognized—which we are partially working out by developing improvements of detail and without change of fundamental principle. And some of these will be solved with the aid of science in different and better ways in years to come and then our descendants will say these problems were simple in the light of their knowledge.

What reward could be too great for a man who develops an entirely new principle that is revolutionary in a great industry and that effects economies amounting to hundreds of millions of dollars? At least we should provide some recognition that would help us to remember the names of such benefactors.

It was a natural step to the operation of a real creamery that could serve a whole community. The primitive dash churn was replaced by another style, and then by others. Butter workers came and went, and better ones always took their places. Finally the great combined churns and workers were developed. About a third of a century ago certain epoch-making improvements in dairy processes were brought out. We learned to use heat to destroy bacteria in milk, and Storch introduced commercial starters, and Babcock brought out a butter fat test. In rapid succession there followed Mann's acidity test, perfection of methods of pasteurizing milk and cream, and new methods by which the butter maker could control cream ripening and churning.

The developments in the art of buttermaking are only one example of what has been going on in dairying. Advances in cheese making, which also is a very old industry,

have been marked. We have learned to control flavors in butter and cheese and to produce almost any desired flavor as easily and as definitely as a painter can control the color of a house.

DAIRY MANUFACTURES

In 1919, 1,648,505,382 pounds of butter were made in the United States. This is more than six times the amount made in Denmark, more than eight times the amount made in Canada and more than nine times the amount made in Australia. The production of butter in this country is equivalent to an average output of 2250 tons every day of the year. The annual output of cheese is about 400,000,000 pounds. The average per capita consumption of butter per year in the United States is 17.5 pounds. It is larger in Canada, Australia, New Zealand and Denmark. Our average per capita consumption of cheese is 4.2 pounds. This is exceeded in nine foreign countries.

Ice cream making was started as a wholesale business in 1851. It has developed to enormous proportions. - Over 200 million gallons are made annually in factories in this country, an average of two gallons for every person. Ice cream is no longer a luxury. It is an important food. Its manufacture in a commercial way is entirely an American development. We did not import methods of manufacture as in butter and cheese making. A modern ice cream plant contains glass enameled tanks, intricate machinery, and the latest developments in refrigeration. The demand for sweet cream to be made into ice cream has increased the demand for sweet cream for buttermaking. These two demands in turn have served to stimulate better methods in producing and handling milk.

The manufacture of condensed and evaporated milk began about seventy years ago. Methods have steadily

improved. The annual output in the last census year, 1919, was over two billion pounds. It is being sent to every corner of the earth. The exports for 1920 were approximately four million pounds.

Later came the manufacture of milk powders. These and condensed milk have proved their value but never better than during the last war.

By-products from major dairy manufacturing operations are now made in large quantity and include milk sugar, paper-sizing, insecticides, and a long list of articles that are made wholly or in large part from milk constituents.

MARKET MILK

Changes in the manner of handling milk, especially so as to protect it from contamination and deterioration, have been as extensive as the better known changes in methods of making butter. Only a few years ago it was the rule for dairies to be unsanitary. Very little information was available in reference to the production of clean milk. Milk producers and milk dealers did not know the meaning of sanitation. Milk was produced in unclean surroundings and impure air, dipped with and poured into unsterilized receptacles. Often it was exposed to dust and other contaminations. To a large extent these offenses have been overcome.

Market milk, especially for cities having intelligent milk inspection, is produced under sanitary conditions and is handled through pasteurization and cooling, in well-made, carefully sterilized utensils. Pasteurization has become a common procedure as a means to protect against undesirable organisms that may find their way into milk even with the most careful methods of production. Great developments have occurred in methods of refrigeration for milk plants and in equipment for milk shipment. Glass lined tank cars

are the latest improvement for hauling milk. The present day machinery for pasteurizing and filling and capping and for washing bottles and cans is so highly developed as to require well trained experts for operation. In a modern milk plant the milk passes from receiving room to refrigerator storage by way of automatic machines.

THE DAIRY COW

The improvement of the dairy cow herself is more wonderful than any of the mechanical improvements that have been mentioned. The yield of milk and butter fat per cow has been raised year after year until now the records seem almost incredible. For the Holstein breed the high butter fat record is held by Belle Pontiac, a Canadian cow; she produced 1,258.4 pounds of butter fat in one year. In the Guernsey breed the record is held by Countess Prue, with 1,103.28 pounds of butter fat. For the Jerseys it is held by Lad's Iota—1,048 pounds. For Ayrshires it is held by Lily of Willowmore—955.56 pounds. These figures are splendid proof of the work of dairy breed associations. The systems of registry and advanced registry and other special recognition for superior animals are doing much to bring up the average yield as well as to make new individual high records.

But it is well known that the great majority of cows are not pure bred. Efforts for their improvement are being made by the dairy test associations. The federal dairy division reports that the average dairy cow of the United States annually produces approximately 3700 pounds of milk containing 160 pounds of butter fat. According to about forty thousand yearly individual cow records the average annual production of cows in testing associations is 5,980 pounds of milk containing 246 pounds of butter fat. There

are now in this country 513 cow test associations and these have been developed during the last sixteen or seventeen years.

A monthly circular letter covering the work of cow test associations in one state for last August contained several pages of interesting figures showing the rank of different herds and animals in different herds and included a few paragraphs of pithy educational matter for the members of these associations. For example it was shown that the average feed cost per pound of butter fat for three common bred cows was $28\frac{2}{3}$ cents while the cost for three grade cows of dairy breeding was $15\frac{1}{2}$ cents. The average feed cost for 100 pounds of milk for the common cows was \$1.13 and for the three grade cows of dairy breeding it was 53 cents. The significant question is asked: "Do you keep poor cows or do good cows keep you?"

A report for six herds in a Michigan association which has kept records continuously for nine years shows an average gain of 685 pounds of milk, or 51.8 pounds of butter fat, the average percentage of fat having increased from 3.91 to 4.29. The average profit is still more interesting because there were large increases in cost of grain and roughage. It went from \$21.71 to \$36.13.

Dairy test associations are putting great emphasis on the use of good bulls. One hundred and sixty bull associations have been formed. Records show that the fat yield may be increased in one generation by about 50 per cent and in two generations by more than 100 per cent by the use of good bulls.

Enough has been said to show what would be included in a dairy picture typical of conditions in 1922.

FUNDAMENTAL SCIENCES

Dairy developments have come from the application of certain fundamental sciences such as genetics, chemistry, bacteriology, physics and economics to dairy practice. Dairy science really is made up of these sciences as they apply to dairy operations just as medical science is made up of certain fundamental sciences as applied to medical practice. Dairy education and research cannot be expected to make much progress unless these fundamental sciences are well taught. They are more necessary than ever. The easier problems have been solved. More skill is needed to solve the harder ones.

The world renowned Babcock test and the most conspicuous work upon the food values of dairy products have been accomplished by men with strong chemical training. Most valuable work in relation to pure culture starters and dairy sanitation has been accomplished by men who were trained especially in bacteriology. Improvements in creaming milk and churning and in dairy mechanics generally have been developed by men who understood certain principles of physics. Most of the dairy improvements have been brought out by specialists in one or more of the fundamental sciences and who had a clear understanding of progress and needs in the field of dairying. A notable development in the dairy departments of our institutions is the appointment on the staffs of such specialists or the development of intimate relations with the fundamental science departments of the institution.

PRESENT NEEDS

The needs for dairy development that now seem to be most urgent are the further improvement of the dairy herd, greater economies in manufacturing, improvement in the quality of dairy products, better systems of marketing, and

the development of a better appreciation on the part of the public for high quality dairy products. These improvements are desirable because of our own pride in the industry. They are necessary if we would hold our position in the world's markets and in our home markets.

In other countries progress is being made along all these lines. Five foreign countries are reported as having a larger yield of milk per cow than the United States—The Netherlands, Switzerland, United Kingdom, Denmark and Germany. In Holland and Denmark great progress has been made in the coöperative manufacturing and selling of dairy products. The dairymen have found it to their financial advantage to combine and employ expert assistance to help in these matters. We will see more coöperation in dairying in the United States. Our country cannot afford to allow others to do better than we do. Unless we keep up our quality and keep down our costs, other countries will take our daily business away from us. A prominent importing firm in London recently has made the following statement: "It is gratifying to feel that the quantity of butter received from Empire sources now exceeds that produced by foreign countries, whereas before the war the proportions were 20 per cent and 80 per cent respectively." This gives some indication of dairy developments in other countries.

One great need is to educate the public as to the food value of milk and other dairy products which constitute about 18% of the American dietary. Comparisons are often made between dairy products and other foods. At current prices milk and its products are cheap foods of animal origin. It seems hard to make the average householder realize that in food value one quart of milk compares well with eight eggs or three-fifths of a pound of ham or three-quarters of a pound of beefsteak or two pounds of chicken. Still less does the public know of the vitamine content of milk and what this signifies.

DAIRY INSTRUCTION AND RESEARCH

Dairy schools and courses of instruction in dairying in the agricultural colleges have played an important part in the development of the industry. More or less well adapted equipment for dairy instruction has been in use in institutions in some of the leading dairy states for more than twenty-five years. At first the instruction related to butter and cheese making and milk testing. Most of it was practical. Most of the courses were given in the winter and continued only a few weeks. Very few lectures or recitations were held; in one leading school thirty years ago the maximum instruction in the class room consisted of four lectures, not per week but per term, one each on milk, milk-testing, buttermaking and cheesemaking. There were also a few lectures on breeding and feeding. Then we saw improvements in these lines of instruction due to the beginning of research. More lectures were given. The relations between fundamental sciences and dairy practice were being better understood. Instruction was strengthened. New lines were added, such as market milk and ice cream. The first exclusive ice cream laboratory in a college, so far as I am informed, was established in 1910. The modern dairy department curriculum provides instruction for every branch of dairy work. Courses are offered extending in length from six weeks to seven years. In several states magnificent buildings have been erected and equipped with the most up-to-date machinery and laboratory apparatus. One such dairy department has sixteen highly trained staff members.

DAIRYING IN CALIFORNIA

In California twenty-five years ago, according to official announcement, a special dairy course was not offered but some closely related instruction was given. Equipment

consisted of a laboratory for the analysis of dairy products and feeding materials and containing apparatus for milk testing. A course of three lectures per week extending about six months treated of stock breeding and dairy husbandry. A course was given also in dairy feeding and a laboratory course was given in the chemistry of milk and dairy products. Small laboratory fees were charged, and the report adds that students in the California College of Agriculture could secure board and room for \$20.00 per month.

At that time the dairy interests of California were of considerable importance though not large in comparison with your other greater interests. According to Louis Tomasini, manager of the Dairymen's Union, there were in 1894, 333,310 cows in California and the quantities and values of dairy products were given as:

31,116,600 pounds butter at 19c.....	\$ 5,912,154
9,000,000 pounds cheese at 9c.....	810,000
50,000,000 gallons milk at 12c.....	6,000,000
Skimmed milk, etc., as pork.....	1,037,220
Calves at \$2.00.....	666,620
Total.....	<u>\$14,425,994</u>

The federal census showed that the value of dairy products of California was 75 per cent larger in 1909 than in 1899 and 175 per cent larger in 1919 than in 1909. The California Department of Agriculture reports the approximate value of dairy products in this state in the year ended June 30, 1920, as \$99,004,358. Mr. Greene, the Secretary of the Dairy Council, gives the present value as about \$85,000,000. This is over six times the value of corresponding items as given by Mr. Tomasini about twenty-five years earlier. The rapid development of this industry and its present large proportions mean much to California because of the wholesome and necessary food it furnishes and because of the

large number of persons employed and the great amount of capital invested but this is not all. The dairy industry helps to diversify agriculture and it helps to upbuild the state. It improves the soil. It furnishes employment and income throughout the entire year. No state is so wealthy or so independent that it would not appreciate these benefits. Agriculture with its many farm homes in large areas in some states literally has been saved by the dairy industry when all other sources of income had failed.

THE NEW BUILDING

Because the state of California appreciates all this, we are here today to dedicate this building to service of the state through the dairy industry.

We see a structure 234 feet long and two stories in height with a one story wing 128 feet long and 64 feet wide. It is equipped with machinery and apparatus necessary to conduct research and to give instruction along dairy lines as required in this state. It seems to be the last word in college dairy buildings and much could be said in praise of the work of the architect and builder and especially the careful study of the whole subject that evidently has been made by Dr. Roadhouse and his colleagues.

The building cost about \$200,000 and the equipment about \$30,000. This represents an investment of about seven cents for each person in the state. Seven cents is a trifling sum when compared with what the average person spends in a year on non-essentials—for example about two dollars for candy and chewing gum and about four times that much for admission to entertainments. I wish that something could be said here to bring home to each thinking person in the state the fact that he has a personal interest in this building and the work that will be conducted here.

ATTITUDE TOWARD AGRICULTURAL EDUCATION

The state of mind of the public on the question of agricultural education has undergone great change in the last few years. We are coming to recognize that agricultural education is a public question—that it concerns the general public even more than the farming classes.

We have been conducting agriculture in about the same way as we have exploited the non-agricultural resources of the country. We have depleted our reserve supplies without regard to posterity and even without regard to our own old age. People now recognize the mistake and they are glad to support efforts which will check the losses and wastes and which will help to establish agriculture on a more permanent basis.

In New York state with its great population, the subject of food supply had become so serious a few years ago that state and city committees began investigating. Those committees finally united in a recommendation that the system of agricultural education should be strengthened and expanded. They said: "State agencies for agricultural education and research are a prime requisite in this connection. The state should lose no time in extending the work already under way in its various agricultural institutions. We recommend these institutions be instructed to submit plans and estimates as to what will be required to extend their facilities in the way of additional buildings and equipment and the securing of a larger staff." The joint report showed also how in the United States we are behind European countries in respect to certain agricultural educational developments. It points out that in recent years Norway, with a cattle population of only 1,100,000, expended \$600,000 for a new veterinary college and equipment. Twenty-five of our states have more cattle than Norway (California has

over two million) but the good veterinary colleges in the United States can be counted on the fingers of one hand. The report continues: "We believe no better investment could be made on behalf of the people than appropriations by the legislature along these lines."

THE DIGNITY OF EDUCATION IN THE INDUSTRIES

This building as a part of the equipment of a great university is another proof that the worth and dignity of education in the industries is coming to be recognized by the American people. Here in California, having enormous agricultural and industrial interests, one would expect the public to regard technical education as highly as equivalent education along other lines. Yet there are many objectors. Some persons think education along technical lines is not and never can be the equivalent of the older kinds of education along cultural lines. These persons are a remnant of a considerable group who looked down upon agricultural education sixty years ago and some of whom never will become reconciled to the new order of things.

Higher education in agriculture should be conducted on a plane comparable with the educational standards relating to higher education along other lines. This is being done in our leading institutions. If this were not done and if higher education in agriculture were not regarded as the equivalent of other kinds of higher education it would be avoided by ambitious, talented American boys. That would be a disaster to our country.

I say that education in agriculture is as dignified as education in any other subject—for example, the law. To understand the sciences that relate to agriculture is to understand God's laws. Can anyone say this is less dignified or less worthy than it is to understand the laws made by

men? Can anyone say that it is less worthy or less dignified to understand the laws that govern the struggles of myriads of bacteria in the soil than it is to understand the laws that govern the location of line fences or trespass on top of the soil?

As to the attitude of the American boy, this seems to be the same now as it was in 1852 when Honorable Charles B. Calvert, of Maryland, argued in favor of establishing an agricultural college and experimental farm. He wrote these words:

“The agricultural community has long felt the want of such institutions, and it is to be hoped that the present generation will do something to elevate the standing of the profession by establishing colleges and schools which will enable the sons of agriculturists to obtain, not only a liberal, but a professional education. The learned professions, as they are commonly termed, have engrossed most of the talent of all nations. Is it because those professions are more honorable in themselves than agriculture? Certainly not. Is it because those professions are more honorable in themselves than agriculture? Certainly not. Is it because they require more talent, learning and energy? It will not be pretended that they do. Then why is it that you find the most talented and promising sons of agriculturists deserting the profession of their fathers for some one of these?

“It is because they are endowed by nature with a certain ambitious thirst for distinction, which they feel can only be gratified by uniting themselves with some one of these professional combinations. What is the remedy necessary to remove this incubus which is consuming our vitals? Simply, education—for so soon as you give a professional and at the same time a liberal education to the farmer, you at once arouse a professional pride to make his own the most honorable of all pursuits; and it is only necessary to arouse this pride to enable the agricultural community to take the position

which their intelligence and numbers entitle them to. It cannot be denied that the agricultural community composes the great conservative power of this country—and it is impossible to disguise the fact that we are daily departing from the great principles laid down by the wise men who formed the happy government under which we have become a great and powerful nation. We see daily combinations formed in large cities to manufacture public opinion in favor of some scheme originated solely for the benefit of some selfish individual or political party, without any regard to the great interests of the country. If, on the other hand, the agriculturists were, as a body, liberally and professionally educated, they would take that stand in the political community which their numbers and interests entitle them to, and thereby control such matters; and I therefore trust that you will see the importance of such an establishment in our state, and will give it your active support, by obtaining as many and as large subscriptions as possible.”

This letter is a classic, true in its day and just as true at this time.

My argument is that agricultural education, as developed in our best institutions, is equivalent to other forms of education and this should be universally recognized. Some of our best scholars in other lines frankly acknowledge that the whole subject of research in this country has received impetus from research conducted in the field of agriculture. One historian records the fact that the work of research in a few state universities began in their departments of agriculture. From these departments the endeavor for scholarly research extended into the departments of liberal arts and science.

EARLY EFFORTS FOR INDUSTRIAL EDUCATION

It is amusing, though sometimes saddening, to read of the struggle made by the few who were first to see the need and worth of education along industrial lines. About 1840, according to Dr. Dabney in his "Education in the United States," President Francis Wayland of Brown University became interested in scientific and technical education. He wrote a book on the collegiate system of the United States and argued earnestly in favor of placing scientific subjects in the college curriculum. He succeeded in securing a science hall and a museum of geology at Brown University, but Francis Wayland was ahead of his time. Support was withheld from his scientific courses and he was forced to resign in 1855 and the old classical course was reestablished. President Wayland had studied the enrollment at New England colleges and found the number of students to be decreasing in spite of increases of endowments and reduction of tuition. He wrote, "It would seem from such facts as these that our present system of collegiate education is not accomplishing the purposes intended. * * * Our colleges are not filled because we do not furnish the education desired by the people. * * * We have in this country 120 colleges, 42 theological seminaries, and 47 law schools, and we have not a single institution designed to furnish the agriculturist, the manufacturer, the mechanic, or the merchant with the education that will prepare him for the profession to which his life is to be devoted."

A monument should be erected to the memory of President Wayland by us who believe in a dairy building as a part of the equipment of a great university.

The early educators simply could not understand. One who was interested in Greek made an attack upon "the buttermakers across the campus" for wanting to put their sub-

ject on a par with Greek as a part of a university education. Yet in 1896 President Walker of the Massachusetts Institute of Technology referred to the oldest university of America conferring its degree upon those who had never had an hour of either Latin or Greek within its walls and even dropping Greek from its list of entrance requirements. He said, "We get a measure of the enormous advance in educational philosophy which has taken place since President Wayland dared to challenge the opinion then universally held by the teachers and governors of American Colleges and universities, that the classics were absolutely essential to liberal culture and that no one could be called well educated without them."

When the bill to establish land grant colleges was first introduced in Congress it was not popular and it failed of passage. In 1859 a Mr. Davis argued in Congress against the Morrill land grant and he said,

"I have seen the growth of the proposition to do something for the agricultural interests of the country and I believe it was always delusive not to say fraudulent. It needs no aid. The agricultural interest takes care of itself and is drained to take care of every other pursuit in the country.
* * * Agriculture needs no teaching by Congress. The wide extent of the country, the great variety of its soil and climate and products render it impossible that there should be anything else than local teaching in relation to agriculture."

Times have changed. The man who teaches the science of buttermaking or how to conduct egg laying contests has come to be looked upon throughout the length of the land with the same respect as the one who teaches arithmetic, physics, history, or Latin. All these subjects are important. The American boy will make no mistake in selecting the one which appeals strongest to his own taste.

WHAT THE NEW BUILDING MEANS

I have tried to tell what this building stands for. It is a monument to the past. It represents progress of dairy science and of the dairy industry down to the present date. It also is a starting place for the future. We dedicate it not to the past but to the future, for as service beginning now. No one would venture to say how great this service will be nor how far it will reach. Most of us are able to see developments only along the lines already started. Much needs to be done along these lines.

But the scientists engaged here are likely to find themselves working on problems that today are unthinkable. We must not assume that we can see the limit of the field of knowledge. Surprises are in store for us now the same as they were in store for us forty years ago. No one then had imagination enough to foretell the developments we have witnessed. Nearly fifty years ago a thoughtful business man remarked to some friends that the time would come when street cars would be driven by electricity. His statement was received with laughter. Can you imagine the surprise of the young Dutchman who first made a lens and through it saw forms of life which no one knew existed? Steadily our scientists are opening to our view new worlds. We cannot think the last word has been spoken in dairy science. New epochs in dairying are ahead of us.

DEDICATION

The world today needs men and women who can think straight. The farther they can carry such thinking beyond the daily routine and their special line of work, the better for all. Here you have provided equipment for the development of such men and women in the field of dairying. They

and others similarly trained in other fields will control the future of our country. They will stand a little higher and see a little farther than most of their fellowmen. The technical training they receive here and their habits of clear thinking which will be stimulated here and their loyalty to state and nation which will be strengthened here will make them leaders in attacking problems and overcoming difficulties and thus they will help California to maintain and further advance her high standing as a great state in the union of all states.

To this high ideal this building is reverently dedicated.

THE OUTLOOK OF AGRICULTURAL RESEARCH

WILLIAM HENRY CHANDLER

Professor of Pomology and Vice-Director of Research in the New York State
College of Agriculture at Cornell University

I am certain that you do not look upon the dedication of this building merely as a celebration of a feature in your splendid growth, or as a means of calling attention to the very rapid development of the system of agricultural education. I know you will agree with me that any system or institution that develops very rapidly, should be examined frequently as to the soundness of that development, and that such occasions as this should be used, not for boastfulness, but humbly to question ourselves as to whether or not, with the generous support we are receiving, we are keeping faith with the public of today and that of tomorrow.

Carlyle has said, "Welcome the beggarliest truth so it be one, in exchange for the royalist sham. Truth of any kind breeds ever new and better truth." In the extension service much is said about developing salesmanship. I dislike the expression. But the one commodity that justifies our organization is truth. Yet I am certain that we have also a considerable number of shams. I am certain that, in my own field, public money is expended in teaching not only what is not altogether true but also, in some cases, what is the opposite from the truth.

These may, perhaps, be dismissed as of little importance being, it seems, inevitable in a system that is growing rapidly. However, there are features in our development that, it seems

to me, are worthy of very serious consideration. The son of the engineer or of the doctor, though much associated with his father in his work, could hardly, from that association alone, learn to do the work as well as his father. So extensively has science entered into the daily routine of these professions that training other than that to be secured through experience is indispensable for even mediocre practice. This is not true in agriculture. The son of a good farmer may surpass his father without ever having attended an agricultural college. If the college possessed no practical information not possessed by the better growers, the farmer's boy might well study the sciences and economics in order to learn explanations of his practices and for other benefits of an education, but he would find little in the practical subjects. Few of us believe that an extension service could long be very useful unless the workers possessed knowledge not possessed by the best growers. That is, an extension service maintained for the purpose of bringing to the attention of incapable growers the practices of the successful ones would not be very effective. It does not seem that the extension service of such departments as Pomology or Dairy Industry could profitably exist without a growing body of truth.

If we could be certain that when a department, or a college, had ceased to possess information in advance of that possessed by the best growers it would be discontinued, there would be less need for concern. However, public institutions are not so treated. If a man should possess no information of value to capable farmers, but only the power of pleasant, or even forceful, though useless, discourse, he could preach dependableness and industry to the shiftless and the lazy, and success to the ne'er-do-well and society would support him. For it is not willing to admit the futility of such a

proceeding. He might still be a voluble champion of the farmer's interest, or imagined interest, in all public controversies. He might seek to do the farmer's business or political chores, or to do other things for the farmer that in the interest of his own initiative and self-respect the farmer should do for himself. It is no peculiar discredit to the farmer that he will accept such services and would probably support an institution misnamed educational that could furnish only such services. Most of us are anxious to have flunkies, either at our own or at public expense, even though we know that the effect on us may be as bad as that on the flunky.

With the agricultural college, perhaps more than with any other educational institution, usefulness is dependent upon new truth, that is upon research. What are we doing to make it certain that the interest of research will occupy the position in the college that soundness of development requires? In many of the colleges, if not most of them, there has been little or no increased support since 1914. Considering the number of trained men that have been lost from research to other college activities or to the industries, it is probably true that less attention is being given to agricultural research in this country in 1922 than was given in 1914. Yet, during that time there has been very great development in extension activities that must lean upon research.

However, it may be possible to place too great emphasis upon the lack of support since 1914. Unquestionably a considerable number of studies by effective workers have been rendered less fruitful by lack of funds with which to purchase equipment and to employ routine assistance. However, it is certain that such rapid expansion as that which has characterized the extension service could not

have led to proportionately increased results in research. The reason is obvious. Well trained workers could not have been found in such large numbers. In fact, lack of trained workers has probably been more important in limiting the results of agricultural research than lack of financial support. It seems probable that many of the men who have left research activities were never doing very effective work. It is not a criticism of earlier workers in the experiment stations to say that before there can be any rapid advance in agricultural research there must be a larger number of highly trained men in the agricultural colleges and experiment stations. And training cannot be measured by the number of degrees held. It must be measured by knowledge of the literature and skill in the research techniques of some well developed field. Most agricultural subjects like Pomology and Dairy Industry have not developed an effective technique of their own. Since they are so closely related to such general sciences as chemistry, botany, and bacteriology, it is doubtful if they ever can or ever should offer courses adequate for the development of a fine research technique. In training their workers, they must coöperate with the fundamental departments. It is true that the pomologist must know a lot of practical details before he can safely or effectively apply scientific principles to orchard practice. But such knowledge can readily be acquired through daily experience and its possession is no justification for lack of the knowledge and technique of botany and chemistry necessary for effective study of trees.

Indirectly, the agricultural colleges have influenced the development and solidification of large and effective agricultural organizations that are coming to have great influence in public councils. The colleges, it seems to me, are therefore placed under a very great obligation to study the econ-

omic problems in which these organizations interest themselves. When the leaders of such organizations exert their influence upon public officials they, as well as the officials, should be under the compelling influence of carefully determined truth. While, perhaps, I am only displaying my ignorance, I believe that the workers in Agricultural Economics and Farm Management, by leaving their desks and studying the problems out in the country or in the markets where they are to be found and, generally, studying the small problems first, have developed, or at least brought into large use, a method of attack that may increase the effectiveness of economists generally. However, I do not believe that agricultural economists can dispense with the training to be secured in departments of general economics. They must see in their problems not the interest of the farmer alone, but that of all society. In their training, they should become broad economists who expect to specialize in agricultural economics. If they should see only the interest of the farmer, their influence might in the end be detrimental even to the farmer. For, while I do not possess the knowledge, I have enough faith in things as they are to believe that no group can secure benefits to itself at the expense of others without in the end injuring itself also.

Some of the methods advocated for improving the effectiveness of research do not seem very promising. Much is said about coöperation of men with different trainings to attack problems in an exhaustive comprehensive way. As early as 1620 Francis Bacon advocated such coöperation, perhaps more brilliantly than anyone has ever advocated it since. That was much nearer the beginning of modern science and if the principle were sound it should have had great influence on the development of science. Yet research has not generally been done in that way.

However, it is not true that there is no effective coöperation among scientists. If we are to accept the views of a specialist in the history of science,* the development of modern science—excepting mathematics and other sciences depending upon mathematics—was but slightly influenced by Greek science. In fact, its methods have been in the main almost opposite from those in Greece where freedom of speculation was generally very great. In a Greek scientific treatise conclusions only are found and little, or nothing is said of the experiences or observations upon which the conclusion or speculation is based. In the early development of modern science such philosophical speculation was not permitted, and the earlier expression of modern science was in the form of invention of practical devices and description of useful experiences or observations. It seems possible that the restrictions placed by church and state authorities upon the early scientists may have influenced permanently the trend and customs of science. However that may be, the characteristic method of the modern scientist is minutely to study a rather narrow problem and, after a brief review of other evidence, to report his observations in sufficient detail that other workers, acquainted with the technique in his field, can use such knowledge in further study of the problem or in study of a related problem. Among well trained scientists, speculation or generalization usually follows the publication of many such papers. This method of publication is in itself a great system of coöperation; and one in which the individual is not forced to twist his own soul into the grooves of an associate's, but retains his own initiative. He may be coöperating with his nearest neighbor or with

* Singer, Charles. *Greek Science and Modern Science, a Comparison and a Contrast*. University of London Press. 1920.

..... *Greek Biology and Its Relation to Modern Biology: Studies in the History of Science!* 1—101 Oxford Press. 1921.

men on different continents; with workers of today, those of past centuries, or those yet unborn. It is doubtful if another such splendid system of coöperation is to be found.

Much is said about the effectiveness of coöperation in research during the war. A very large part of the research done during the war was in reality a searching of this system of literature and a study of methods of using, on a large scale, truth already in the literature. Thus, the production of a chemical substance many years ago, its discovery being of little importance before the war, became of outstanding importance during that emergency. This, it seems to me, should be an object lesson to those who control the means of support for agricultural research. Because the results of a study are not of immediate practical value is no indication that they may not later be used, together with other results, in the solution of practical problems; or that they may not be very useful even alone in meeting some future emergency. I sincerely believe that no results of human endeavor carry greater assurance for the future of civilization than this body of scientific literature; and that nothing more useful can be done than to add to it regardless of immediate application—with the faith that any truth is eventually of service to the human race.

While formal organized coöperation in research does not seem very promising, a neighborly spirit among the workers in related fields is indispensable. Such neighborliness should be a means of avoiding the placing about the workers, restrictions that kill initiative and deaden enthusiasm. One of the worst of these is sharp departmental boundaries. The finest administrative organization is coarse and clumsy when used for defining the activities of a subtle creative human mind. In undergraduate teaching such boundaries should perhaps be somewhat rigid, but in research they will

inevitably be crossed many times if the workers have any originality. It is objected by some that this may cause confusion in the extension teaching. When a study is stopped at a departmental boundary, it generally means that what is taught in extension must be without the new truth that would have been learned if the study had not been restricted. New truth often brings temporary confusion. It seems, however, that temporary confusion, with the ultimate teaching of carefully determined truth, is better than continuous lack of the information the farmer needs—or, what is worse, continuous giving of misinformation. The more limitations there are placed about the workers in the development of their research, certainly the more stereotyped and visionless will be their activities. Yet, some departments whose fields are none too large for any but plodding or puny minds, are organizing into still smaller fields with more rigid restrictions against working in any but one's own little field—or patch—than should prevail as between large departments. Specialization is desirable; but it should be personal specialization; and rigid departmental boundaries, by artificially confining a man's activities, prevent such personal specialization. When such a neighborly spirit prevails in an institution that the plant physiologist is glad to give advice to the horticulturist or the agronomist who may be doing work requiring physiological knowledge and technique, or the horticulturist or agronomist is glad to give advice to the plant physiologist who may find his problem leading into one of these fields, generally, the results will be better than if each man should insist upon being formally connected with the study of any problem that touches his field. Naturally if two men in different departments should find their interests leading to the same problems, the best arrangement would be for them to coöperate; but unless their regard for each other is such

that, upon their own initiative, they will make such arrangements, institutional pressure toward coöperation will generally result in confusion, ill feeling, and ineffective work.

The scientific literature, particularly the biological portion, does not contain—and will not soon contain—a system of principles that can be used, in the solution of practical problems, in the direct and precise way that mathematical formula are used. Rather, it is but a loosely classifiable body of knowledge, applications of which must, in nearly all cases, be studied by someone acquainted with the practices and methods of the industry to which it is to be applied. And, while fundamental research should receive the utmost encouragement, it should not be expected, often, to furnish the immediate solution of agricultural problems. Attempts at such direct application may be very harmful. The problems must be studied as they present themselves in practice. While field experiments and other practical, or somewhat superficial, studies may not yet have yielded all that was expected of them, I believe it would be unfortunate for agricultural science if such studies were discouraged. And a study of the development of science gives us assurance that the results of such work may be of great importance in the development of fundamental systems of knowledge. The very promising development of colloidal chemistry has been, to a large extent, a piecing together of the results of such practical studies and of practical experience. However, such studies, to be most effective and to be applicable to conditions other than those under which the experiment is done, must be planned and interpreted in the light of fundamental truth. Thus an experiment in pruning should be, not merely a comparison of pruning practices, but a study of the various responses of the tree to pruning at different times or in different ways. It is not enough to know only the effect on

yield and growth; for that effect might be different under different conditions. If it is known through what fundamental processes pruning affects yield and growth then the results can be more wisely applied to conditions somewhat different from those under which the experiment was done. The experimental error in practical tests is very large and the number of individuals under trial can seldom be large enough that calculation of the probable error can always be a dependable means of avoiding erroneous conclusions. Perhaps the greatest certainty results when the study begins with the practice, but is followed back to its connection with the general system of truth about plants and animals—or about other features of the farmer's environment. If it is found that the results secured are in agreement with fundamental principles, they can be more safely used even where they are secured; and they can be applied to much more diverse conditions.

However, the system of knowledge has many gaps in it and until these are filled by fundamental studies conclusive information concerning many of the farmer's problems cannot be secured. Research in fundamental subjects should, therefore, be encouraged not so much for its immediate practical bearing as because practical problems cannot be solved, conclusively, until the system of fundamental knowledge is more nearly complete. Research in the sciences like botany, zoology, bacteriology and bio-chemistry should, it seems to me, receive from the agricultural colleges as generous support as that given in subjects like horticulture or dairy industry. The practice of keeping these fundamental departments so small that the workers are smothered under a load of required teaching must greatly delay the conclusive solution of the farmer's problems. While the best plan seems to be for the workers in these

fundamental subjects to seek the truth for the development of a complete and orderly system of knowledge, and for men in applied subjects to start with the problem as it presents itself to the farmer and follow it back to its connection with the fundamental system of truth, experience indicates that the workers in the fundamental subjects will also make many discoveries of immediate practical value and the workers in the applied subjects may make large contributions to the system of fundamental knowledge. And there is no difference in the amount of training required for the two types of study. The time will soon be past, it seems to me, when useful studies in applied sciences can be made by a worker whose training does not enable him to follow his problems back to their connection with the great body of fundamental truth.

It is probable that much the larger part of the scientific literature is a result of the work of teachers; and for best development of the system of agricultural education, teachers should generally be encouraged to give some time to original studies. Only a rather small percentage of trained workers are very effective in research and it is of the greatest importance that all such effective workers be found and given the utmost possible support. To deny teachers time and support for research would be greatly to reduce the number of men among whom the brilliant effective workers might be found—and incidentally to withhold from students contact with men thrilled by the pursuit of new truth. The teacher's work gives him a training that is very valuable in selecting problems for study. He is forced to organize his knowledge each year and may, therefore, know better than anyone else where work can be most effectively done in order to fill gaps in the system of knowledge. In most of the larger schools, at least, it should be possible for teachers to do more

research without harmful effects upon their students. The introduction of new courses has proceeded very rapidly in the agricultural colleges; yet twenty years ago when not nearly so many courses were offered, those of us who were students felt that the teachers were hard pressed for subject matter, and it seems almost certain that the literature in these fields has not grown as rapidly as the number of hours of work offered has increased. If it should be necessary occasionally to reduce the number of hours of work offered in order that a man who is doing some valuable research might have a little more time for his problem, it is probable that the students would be benefited, rather than injured. If such teachers were given half of the year for research alone, the results, it seems to me, would be much better than if all of the support for research that an institution might have available were given to a few men doing research only. When nearly all of the men in a department are doing some research, not only will there be greater probability that all of the men with great capacity for research will be found, but the research spirit will be stronger. Few workers, though having all of their time for research, will pursue their problems with sustained interest when surrounded by men doing no research.

In agricultural research, more than in other fields, experimental work has been done under the direction of persons not actually engaged in the work themselves. Perhaps more directing has been necessary because of the lack of highly trained scientists. However, as the number of highly trained workers increases, they must be trusted to find and pursue their own problems. They will have become acquainted with the literature and the technique necessary for attacking problems in fields, or parts of fields, so specialized that only they can know what is effective research and what

are the most important problems. It seems much more important that all trained workers have an opportunity to do unhampered research than that ineffectiveness and waste by a few be avoided through the close oversight of a director. The research spirit is a very subtle thing, and may be easily killed by annoyances that seem unimportant to some organizers. It is not an unknown occurrence for a man with a fine reputation for research in one institution to move to another one and do no more original work. If rather busy teachers are led to think that research is not expected of them, if they do not have freedom as to the problems they attack, and, particularly, if they are treated as children and required to make stupid annual progress reports, even men with outstanding possibilities may be driven from research activities.

The most inspiring ideal for the experiment station director is that of a chore boy in the temple of science. He must trust the workers to find and pursue their problems, but he can be of humble service to them. He can help them in securing funds for equipment, fighting for it if necessary as against activities less important than research. In many ways he can assist in developing an appreciation of sound research in his institution—not the least of these ways being to oppose the introduction of any strutting shams. He can oppose institutional boasting over petty discoveries that may happen to have considerable practicable importance—but onto which a fool might have blundered—while the more difficult studies of fine workers are ignored. He can try to make those in control see that the experimental field or laboratory is of value for the truth it yields and not for being tidy, and that money cannot be used at the same time for tidying and doing research. He can oppose the bringing into the institution of any man whose training does not enable

him to follow his problems deep into the body of fundamental truth. Altogether he can work for an appreciation of the fact that what is of importance in an educational institution is unhampered, critical, honest, patient search for the truth. Only in an institution where such a spirit prevails will any considerable number of workers have a sustained interest in research. Preening and strutting are harmful not only because they are expensive and waste funds that should be used for research, but because the research spirit will not thrive in an institution with such practices.

The history of science leads us to think that agricultural research will serve man not alone in a material way. The practical applications of research have served him both physically and spiritually. In fact there can be little question but that the scientific discoveries that have entered into the daily lives of the people have had the greatest educational and social influence. When, with some understanding, a man is constantly manipulating the forces about him, when his physician can explain and often cure even his nervous ailments or those of his neighbor, there is little left upon which to base fear of witches, demons or other supernatural agencies. Thus even his religion, it seems to me, is more hopeful. The part of the universe which he understands is so reassuring that the mystery, left, he accepts with a serene faith.

So in agricultural research, that which today inspires the scientific worker, tomorrow helps the farmer in the service of himself and his fellowmen, not only, but enriches and ennobles his vocation and his life; and our faith is that every feature of his environment shall be so studied that he shall do all his work, live all his life, guided, reassured and inspired by a steadily increasing light of carefully determined truth.

